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prosequendi Invitationem tuam profiscuntur, libenter, ut opinor, videbis. Vale. Patavio. Kal. Jun. CIOIOCCXXVII.

III. *The Imperfections of the common Barometers, and the Improvement made in them, by Mr. Cha. Orme of Ashby-de-la-Zouche in Leicestershire, where they are perfected and rectified; with some Observations, Remarks and Rules for their Use, by Hen. Bighton, F. R. S.*

AS we know nothing more wanting than a Theory of the Weather on Mechanic Principles; there does not seem any thing in all Philosophy of more immediate Concern to us than the State of the Weather.

In order to which, a complete History of the Weather is necessary, to deduce from thence such Rules and Observations as may in some measure form such a Theory: And it may be said, that could we in any tolerable degree foretel, but by some small Space of Time, the Change of the Weather, it would be of admirable Use to us, in those Affairs on which the chief part of our Welfare and Subsistence depends.

It was from such Considerations, that more than 20 Years ago I began, and have continued, to keep a *Diary* of the *Weather* (the six last Years of which I have here subjoin'd); but cannot think myself so well qualified as to form a just *Theory* upon them, though

I am not without Hopes they may have their Uses, when they fall into more able Hands.

Yet I believe I may say, that from them, and the Observations I made by a new *Improvement* of the *Barometer*, (for the same Number of Years) I can generally foretel for a Day, or perhaps two, the Change, or what Continuance the Weather will have.

And although so many ingenious and curious Persons, since the Invention of *Torricellius's Barometer*, have been improving and endeavouring to bring that Machine to Perfection; yet notwithstanding all their indefatigable Care and Pains, the Air that is interspers'd and mix'd with all Fluids, (of which *Mercury* is esteem'd one) has in some measure frustrated their Labours, and it has remain'd imperfect: For whilst there are any small Quantities or Particles of Air remaining in the *Quicksilver*, it will be constantly *rising* in *hot* Weather, and *falling* in *cold*: Which really perverts the very End and Design of a *Barometer*, which should shew the Pressure of the *Air*, and foretel when either *fair* Weather or *Rain* is coming; instead whereof it is in a great measure a *Thermometer*, foretelling *Heat* instead of *fair*, and *Cold* instead of *Rain* and *stormy Weather*: And these Imperfections have all the various sorts of *Barometers* (more or less) that have hitherto been invented.

The *Barometer* I am about to describe, is not different in Form from some usually made, it being of the *Diagonal* kind, from whence the more minute Alterations are more readily discovered: Of this Form many have been made by the late curious Operator Mr. *Patrick*, who has, in his way, well deserv'd of the Curious; who, though he had done so much to-

wards the proving the Weight of the Atmosphere by which the *Mercury* in the Tube was sustain'd, he himself did not believe it, but run into that Absurdity of the *Funicular* Hypothesis.

There is an Inconveniency or Imperfection in most, if not all, of those *Diagonal Barometers*; for after some time, the various rising and falling, and Changes of the Weather, of Heat and Cold, the small Particles of *Air* that have been interspers'd in the *Mercury*, have got together in a larger Mass, as they will incline by Attraction, which will separate the *Mercury*; and that Quantity of *Air* will be dilated by *Heat*, and contracted by *Cold*, so as to spoil the Design thereof.

Besides, there is such a Cohesion or Attrition of the *Mercury* to the *Tube*, (especially in the small ones) that after some time, the *Mercury* that is not truly cleans'd from its Dross, and purg'd of all its *Air*, in remarkable Changes of the Weather will neither rise nor fall. All which Embarrassment is taken off, and the Difficulties surmounted, in

Mr. Cha. Orme's Improvements of the Barometer, by the Method following.

First, The *Quicksilver* is all purified from its Dross and earthy Particles by Distillation; and when the *Tube* is filled by a Pound and half, two, or three Pounds of *Mercury*, and all the *Air* got out by the Methods used in filling *Tubes*, then the remaining *Air* is got out by such an *intense Heat* of *Fire* as makes the *Mercury* boil; by which Ebullition an innumerable Quantity of small Particles are emitted, and blow with a great Velocity at the open End of the *Tube*, till all
the

the *Air* is quite cleared out; which curious as well as fatiguing Operation is continued for the Space of four Hours: And when no more Bubbles would rise in the *Tube*, it remain'd whole, with its *Mercury* of a most lively sparkling Brightness, with this Difference only, that the *Mercury*, so purged from its *Air*, did not fill the *Tube* so high as when first put in by about two *Inches*; which is a plain Demonstration, that in that *Tube*, which was 49 *Inches* long, there was interspers'd in the *Mercury* at first filling it, so much *Air* as would fill two *Inches* of the said *Tube*, which was a 24th Part of the said Space.

The whole Operation I myself attended the 20th of *January* 1734-5.

And further I can affirm, that every Part of the *Mercury* boiled for a long time, and the *Tube* was *gradatim* so red-hot, that with a warm Knife I could make Impressions in any part of it.

And this I the rather mention, by reason I have heard several Persons, and those not incurious, affirm it was impossible.

And that this is the most sure and certain (if not the only) Method for getting out all the *Air*, may be judged by the *boiling* of *Water*, which in its Ebullition does emit a great Quantity of *Air* for a long Space of Time.

The Perfection of these Barometers, which exceed all others I have ever observed in the following Particulars.

1. They are sensible of the most minute Changes of the *Air* whatsoever.

2. They

2. They foretel the Weather by a much longer Space of Time than others, as mostly 20 Hours, sometimes 36 or 48 Hours: Nay, before great Tempests, and such Rains as cause great Floods, for a much longer time before they happen.

3. Although they are so sensible of such minute Changes of the *Air*, yet the most intense *Heat* will not *raise* them a Hair's-breadth, nor the greatest *Cold* make them *fall*. This shews they are perfect *Barometers*, and not in any degree *Thermometers*.

4. You may by them distinguish whether, if they shew for *Rain*, it will be little or much.

5. As by other *Barometers* you cannot tell the Weather, but by a past and a present Observation; these tell you, the Instant of Time you come to them, what the Weather is going to be: For by rapping the Case with your Finger, if it is going to be fair, or very fair Weather, the *Mercury* will rise that Moment a roth of an Inch, or more: But if for *foul*, it will scarce make any sensible Rise.

[A.] The Reason of this I shall explain in the Observations at the End, *Page* 249.

I have had one of the Glasses by me for 10 Years, and have constantly observed its Motions, which has very seldom failed me in foretelling any considerable Change of the Weather.

But as some People have such strange Notions, as not judging afterward whether they were told true or false, and others may miss in their Expectations of perfect Certainties, which none can attain to; it will not be improper to make the following

R E M A R K S.

1. Though you can foretel it will rain on the Morrow, it is impossible to tell where that Rain will fall; for as every Shower has Space, *i. e.* Length and Breadth, if it rains in that particular Field, yet it may be fair in the next adjoining: And if in Harvest, or on a Journey, you proclaim it will rain on the Morrow, some will, if it does not fall on their Land, or on his Coat, be so silly as to say the Prediction was false.

2. The *Barometer* does only shew the Pressure or Weight of the Atmosphere, and Inclination of the Air, in and about the Country where it stands, and not always in a particular Spot; so that in foretelling of great Rains, People are apt to say the Indication is false, because they have not seen or heard of it; when perhaps in a Day or two you will hear, that it did then fall three, four, or may be 10 Miles off. For though the Rain should be over us when the Glass fell, yet the Wind, which bloweth where it listeth, carries the Clouds and Rain with it.

3. It is very hard to distinguish on the *Mercury's* falling, whether it will be Rain or high Winds, they equally causing the *Mercury* to subside.

4. Of all those who guess at the Weather from the Whims of their own Brains, it is observable, it is not true one time in Ten, nor do any two of them agree about it.

But from Observations on this *Barometer*, it will seldom fail you once in 20; so it is above 100 to 1 preferable.

5. If

5. If from the State of the *Mercury* Yesterday and this Morning, it be pronounced the next Day will be no Rain, and I look at the Glass no more To-day; perhaps Winds may arise, and so alter the Atmosphere's Weight, and the Glass falls much, it will rain on the Morrow, contrary to what I at first expected: Here it is plain, had I seen the Glass again in the Afternoon, I might have also foreseen the Rain.

Hence it is evident from these Remarks, that Judgments are taken on the Weather from *Barometers*, which do not prove so; and this begets Opinions in the Vulgar and Ignorant, that there is no Judgment at all to be had from them.

If they could consider, nothing in Nature is certain, permanent and perfect, neither in ourselves, or what we do or think; then why do we expect it in the Air? Is it not subject to as many Chances, Variations and Mutations? Or why should we expect a Foreknowledge of it absolutely from the *Barometer*, and that it should force us to understand its Meaning infallibly?

If the *Barometer* could only foretel very great and remarkable Changes of the Weather; for Instance, in Harvest-time, that a very great Rain, or perhaps Floods, were coming; the Husbandman would stop cutting down his Grain, and save some of it being spoiled by the Wet: Or on a Journey, if I know that if I do not get Home by such a Time, or pass such Rivers, the Floods will be so great as not only to prevent me but endanger my Life: And may be here is a Man's Fortune saved, nay his Life, merely from the Indications of the *Barometer*; and who reckons this nothing, deserves neither.

Do not we reckon a Memory, or a History, good, that calls to mind, or notes every valuable or remarkable Event, though not every Tale or trifling Story?

The greatest Storm that has been in our Days, was *Jan.* 8. 1734-5. On the 5th the *Mercury* began to fall, and on the 8th was a 10th below 28 Inches; which has not been seen in this Age, or perhaps since *Torricellius's* Time; thence I could plainly indicate, that it would be the greatest Flood we ever heard of, or the greatest Storm we ever felt; the latter of which it proved.

Some Rules and Observations for fore-knowing the Weather, by the rising and falling of the Mercury.

Though rising always presages fair, and falling foul Weather, yet there are several Difficulties and Niceties in making a true Judgment from them, and herein consists the chief part of the Art.

I shall not trouble you with the several Observations made by Dr. *Halley*, Dr. *Beal*, Dr. *Derham*, Mr. *Patrick*, and others, though they are most of them applicable to this improved *Diagonal Barometer*, by reason their Esteem has caused them to be in so many Hands, and in most Authors on the Subject, and because I have collected them in order to be made publick, at the Request of the Improver of the *Barometer*, Mr. *Orme*, and for his Use; which some time since were put into the Hands of my very worthy Friend Dr. *Desaguliers*, who is acquainted with Mr. *Orme* and his Glasses. I shall only insert here some few Observations, which I believe may be called Rules, as I

have deduced them from time to time, in using Mr. *Orme's* Glasses, and keeping a Register of the Weather; and shall at the End of this Account insert several more Observations on the Diary of the Weather, now sent with this, which are not yet digested into certain Rules, but may in time, I presume, by some more skilful Persons; or by a longer Series of Observations and Registers of the Weather, which I design to pursue, if Health continue.

Rules and Observations for the improved Diagonal Barometer.

1. This *Barometer* very rarely foretels Thunder, seldom falling at all before it, which Mr. *Patrick* observes others do.

2. In serene and hot Weather, when the *Mercury* is high and rising, and you have all the possible Certainty of fair Weather the next Day, and if there happen to fall great Showers, you may conclude they have been driven upon you by Thunder, though you have heard nothing of it.

3. When the *Mercury* is pretty high, and has fallen to foretel Rain, and it rises again before the Rain cometh; it indicates there will be but little of it.

4. If the *Mercury* continues falling whilst it does rain, it shews it will rain the next Day.

5. In fair Weather when the *Mercury* has continued high or rising, if it falls a little To-day about Noon, and towards the Evening rises again, you must expect a single Shower the latter part of the next Day, (or perchance by Noon) and then fair Weather again forward.

6. When the *Mercury* rises gradually, (about half a 10th perpendicular) and continues so to do for
many

many Days together ; you may reasonably expect a fair Season for as long a time as it was rising, unless some Gales of Wind intervene, and especially the SW by S. or thereabouts.

7. When the *Mercury* rises very fast, or falls very fast, neither the fair nor foul Weather it forebodes will continue long.

8. Without knowing how the *Mercury* has stood some little time before, a true Judgment cannot be given at all times : For suppose I find it in a rising Condition, I am apt to think it will be fair ; but if it had been higher some Hours ago, and fell, there must happen a Shower.

[A.] What I promised in *Page 252.* to explain, was,

Why the *Mercury* in the *Diagonal Barometer* (if it be for fair Weather) on rapping the Case several times, which jars and makes the *Tube* tremble, will rise at every Stroke for several Strokes together, and in all sometimes a 10th of an Inch, or more, in the perpendicular ; may, I presume, be thus accounted for :

1. There is a Cohesion of the *Mercury* to the *Tube*, which hinders its rising, and such rapping releases that.

2. But it is observable, that it will rise a little at all times, even when it is in a standing or even in a falling Condition. This may be accounted for thus :

The *Mercury* and *Atmosphere* are in an *Equilibrio*, and rapping starts and raises the *Mercury* a little in a boiling manner, especially the upper Surface of it, which is seen to leap, or be in a swimming Posture ; then the Pressure of the *Atmosphere* over-balances

the remainder of the *Mercury*, and it must rise a little.

Or such violent jarring puts the *Mercury* in a lateral and upward Motion, (for downward it cannot go) which takes off its Gravity, as the Winds lessen the Pressure of the Air; therefore it must rise a little.

But then it is observable also, that if the *Mercury* was in a standing Condition, or falling, such rising as above, will in a Minute come to the same Place again; and even when the *Mercury* is in a rising Condition, it will, in that Space of Time, fall a little part of that it rose by such rapping.

This *Barometer* has the *Coruscations*, as they were observed in Mr. *Patrick's* pendant one; for by rapping the Case with the Finger in a dark place, it will emit several bright Flashes, along the empty part of the *Tube*.

This I take to be an Argument that the *Vacuum* is very pure, and the *Mercury* truly purged.

I shall not need to say any more, having doubtless already descended to Trifles; only I would add, which I can with Truth and without Vanity affirm, that in all the Affairs of Husbandry, but especially in Harvest, it has seldom failed me in foretelling the Weather so well, as to be very advantageous to me for nine Years together; and so pleasing and satisfactory at other times, that they who never had one, cannot know the want of it; and those only who have used it, are able to know its Usefulness; and that I could not without some Restraint, and more Reluctancy, be without one of these *Barometers*.

H. Beighton.

Col.

Collections from the Diary of the Weather and Barometer, in order to settle Rules for foretelling the Weather by the Barometer.

GREAT STORMS.

Before them the *Mercury* falls three or four Days, and is exceeding low. . .

1734-5. Jan. 4. at Night the *Mercury* at 29.92 Inches.

5. Night 29.66

6. Night 29.2

7. Night 28.1

8. Noon 27.9 Lower

than has been known by $\frac{1}{10}$, and the greatest Storm of Wind ever heard of in this Age, in the South of *England*, as also in *France* and *Holland*.

1736. Jan. 31. 29.47

Feb. 1. 29.15

2. 28.39 Rain
and Stormy.

1734. Aug. 11. Stormy.

GREAT FLOODS.

Before which the *Mercury* falls very much.

1735. Sept. 4. 29.7

5. 29.6

6. Night 29.6

7. 29.25 The

greatest Flood that has been (at *Coventry*, being about the

the Middle of *England*) these 40 Years, and yet the *Mercury* fell but little.

| | | | |
|----------------|-----------|-------|----------------|
| 1735. Oct. 23. | | 29.55 | |
| 24. Night | | 28.8 | |
| 25. Night | | 28.78 | |
| 26. | | 28.85 | |
| 27. | | 28.26 | A great Flood. |

| | | | |
|----------------|-----------|-------|---------------------|
| 1735. Aug. 19. | | 29.3 | |
| 20. | | 29.28 | |
| 21. | | 29.3 | |
| 22. | | 29.2 | |
| 23. | | 29.2 | Stormy, great Rain. |
| 24. | | 29.38 | Floods. |

| | | | |
|---------------|-----------|-------|-------------------------|
| 1735. Dec. 2. | | 29.32 | Rain. |
| 3. | | 29.5 | Fair. |
| 4. | | 28.8 | Rain. |
| 5. | | 28.9 | Rain. |
| 6. | | 29.5 | Fair. |
| 7. | | 29.52 | Great Rains and Floods. |

THUNDER.

The *Mercury* seldom falls for Rains that come by Thunder. See Diary, *June 2. 1735.*

THUNDER.

When the *Mercury* did rise.

| | | | |
|----------------|-------|-------|------|
| 1733. June 21. | 29.16 | 29.56 | |
| 22. | 29.56 | 29.56 | |
| 23. | 29.62 | 29.65 | Hot. |
| | | | 24. |

[261]

| | | |
|-----|-------|---|
| 24. | 29.65 | 29.57 Sultry. |
| 25. | 29.54 | 29.52 Sultry. |
| 26. | 29.51 | 29.59 Great Thunder. |
| 27. | 29.57 | 29.56 A very violent Thunder, from Ten in the Morning to One in the Afternoon, doing great Damages. |

| | | |
|---------------|------|-----------------------------------|
| 1735. June 1. | 29.3 | 29.8 |
| 2. | 29.4 | 29.55 Thunder and great Rains. |

THUNDER.

The *Mercury* fell before it,

| | | |
|----------------|-------|------------------|
| 1733. July 27. | 29.44 | hot, fair. |
| 28. | 29.37 | Wind, Rain. |
| 29. | 29.09 | Violent Thunder. |
| 1734. Aug. 7. | 29.59 | Sultry. |
| 8. | 29.46 | Fair. |
| 9. | 29.25 | Thunder. |
| 10. | 28.87 | Rain Thunder. |

FROST.

A Frost, when the *Mercury* is high, brings Rain.

1731. *March*. The *Mercury* was high all the Month, and no Rain, but what followed the Frost on the 17th and 29th.

DRY SEASON.

In *June* 1729. and the *Mercury* scarce ever above changeable.

In *Aug.* 1730. the *Mercury* never lower than 29.37.

1731. from the 1st to the 10th, and Rain came the 16th, though the *Mercury* was rising.

FROST.

F R O S T.

A great Frost, although the *Mercury* fell ; but it was attended with a great Snow, which might occasion it to subside.

| | | |
|---------------|-------|--------------------------|
| 1731. Jan. 1. | 29.56 | Rain. |
| 2. | 29.46 | 29.12 Rain. |
| 3. | 28.78 | 28.72 Wind. |
| 4. | 28.72 | 28.81 Frost, great Snow. |
| 5. | 28.93 | 29.12 Snow, Frost. |

G R E A T R A I N S.

Although the *Mercury* was rising,

| | | |
|--------------|-------|--|
| 1732. May 1. | 29.28 | 29.25 Wind. |
| 2. | 29.21 | 29.25 Rain all Day, Snow hard from 8 to 11. |
| 3. | 29.34 | 29.0 Rain. |
| 4. | 29.09 | 29.09 Rain. |
| 5. | 29.12 | 29.34 Wind. |
| 6. | 29.44 | 29.46 Fair. |
| 7. | 29.52 | 29.39 Rain and great Floods. |

Great Rain, though the *Mercury* fell but little.

| | | | |
|-------|-----|-------|---|
| 1733. | 24. | 29.6 | 29.54 Wind. |
| | 25. | 29.51 | 29.54 Fair. |
| | 26. | 29.52 | 29.54 Fair. |
| | 27. | 29.5 | 29.39 Violent Rain for more than 11 Hours. |

GREAT RAINS.

The *Mercury* falling very much.

| | | |
|-----------------------|-------|--------------------|
| 1734. <i>July</i> 10. | 29.65 | 29.67 fair, hot. |
| 11. | 29.63 | 29.62 fair, hot. |
| 12. | 29.59 | 29.4 Rain. |
| 13. | 29.29 | 29.13 Great Rains. |

—The *Mercury* falling a great while before the Rain came, and the Rain continued as long.

| | | |
|----------------------|---------------------------|-------|
| 1736. <i>May</i> 19. | 29.75 fair, Wind, | 29.8 |
| 20. | 29.8 cold Wind, fair, | 29.7 |
| 21. | 29.65 cold Wind, | 29.52 |
| 22. | 29.39 wind, clouds, rain, | 29.31 |
| 23. | 29.28 cloudy, fair, | 29.27 |
| 24. | 29.32 fair, | 29.35 |
| 25. | 29.32 clo. Wind, Rain, | 29.24 |
| 26. | 29.15 Rain, | 29.15 |
| 27. | 29.12 Rain, | 29.2 |
| 28. | 29.28 Rain, | 29.23 |
| 29. | 29.37 Wind, cloudy, Rain. | |

| | |
|-----------------------|-------------------|
| 1735. <i>Feb.</i> 22. | 29.43 |
| 23. | 28.82 |
| 24. | 28.9 |
| 25. | 28.76 great Rain. |

Just after hot or sultry Weather, the *Mercury* generally falls.

See 16 *Sept.* 1731.

8 *Aug.* 1734.

After the *Aurora Borealis*, there generally follow high Winds.

27 Oct. 1733. a large *Aurora Borealis*, and the 28th, 29th and 30th high Winds.

See 23 Jan. 1734.

The *Mercury* falling pretty much, and neither Wind nor Rain succeeded.

1733, from the 18th to the 21st it fell 41, and no Wind or Rain at all till the 25th.

Sultry Weather generally makes the *Mercury* fall soon after.

1734. Aug. 8.

After a great Storm the *Mercury* rises very fast.

1734. Aug. 11.

1736. Feb. 6.

Before great Winds the *Mercury* falls very soon.

1734. Aug. 26.

1736. Feb. 8.

The *Mercury* below 28 Inches.

1734. Dec. 15. at 27.9

1735. Jan. 8. 27.9

In Winter, before Frosts, the *Mercury* generally rises pretty fast.

1735. Dec. 12.

Before a Thaw the *Mercury* falls.

1735. Dec. 13.

17.

1736. Feb. 9.

The *Mercury* falls suddenly before a great Snow,

1731. Jan. 4.

1736. Feb. 8.

21.

When the *Mercury* falls for high Winds, and it continues to fall when that Wind is come, it is likely to be tempestuous, or continue some time, unless Rain succeeds.

| | | | | | |
|-------|-----|------|-------|-------------|-------------|
| 1736. | 22. | Nov. | 29.62 | fair, warm | 29.62 |
| | 23. | | 29.49 | windy, warm | 29.32 wind. |
| | 24. | | 29.1 | high Wind | 28.88 28.73 |
| | | | | | Stormy. |

Some of these Collections are quite contradictory to any settled Rules, and such will happen, and others confirm them; but I have collected so very few of a Sort, though the Diary furnishes a great many, that till more are in this manner collected, it will be very doubtful to form any Rules from them: As Opportunity gives leave, I intend to collect many more.